and is provided in the context of the particular examples discussed below, variations of which will be readily apparent to those skilled in the art. Accordingly, the claims appended hereto are not intended to be limited by the disclosed embodiments, but are to be accorded their widest scope consistent with the principles and features disclosed herein.

Referring to FIG. **1**, force and location display unit **100** in accordance with one embodiment of the invention comprises novel force and touch cell **105**, display element **110** and controller **115**. As shown, cell **105** is juxtaposed in front of display element **110** (from the perspective of user **120**). For example, cell **105** may be laminated to the front of display element **110**. Illustrative display element **110** includes, but is not limited to, various types of liquid crystal displays ("LCD", plasma displays and cathode ray tubes ("CRT"). Functionally, controller **115** is similar to prior art controllers in that it provides signals to drive cell **105** and to relay and/or process signals received from cell **105** to a host computer (not shown). Such signals represent where and with how much force user **120** used to touch display **100**. In another embodiment, display unit **100** may include, for example, a polarizer element between cell **105** and display element **110**. Alternatively, the polarizer may be placed outside bell **105** to enhance the perceived contrast ratio of the display unit.

Referring to FIG. **2**, novel force and touch cell **105** of FIG. **1** comprises first and second clear substrates (**200** and **205**), each of which has abutted to one surface a pattern of conductive traces (**210** and **215**) and which are separated by volume **220**. Volume **220** includes a plurality of compressible media elements **225** which permit substrates **200** and **205** to move closer to one another as user **120** presses on display **100**. In combination with drive signals from controller **115** (see FIG. **1**) and conductive traces **210** and **215**, as the separation between substrates **200** and **205** changes, so does the mutual capacitance between traces **210** and **215**. It is the change in capacitance signals detected by controller **115** that represent where, and with how much force, user **120** touches display **100**.

In one embodiment, clear substrates **200** and **205** comprise glass or optically clear plastic between approximately 0.3 to 0.5 millimeters ("mm") in thickness and may be of the type typically used in liquid crystal displays. Conductive traces **210** and **215** comprise patterned indium tin oxide or some other optically transparent or translucent conductor. Compressible media elements **225** may, for example, comprise polyurethane or silicone rubber in the form of elastomer dots or beads.

It has been found that the capacitance change between conductive traces **210** and **215** may be easily detected using glass substrates of the thickness identified above and separated by between approximately 2 to 20 microns ("μm"). Accordingly, in one embodiment compressible media elements **225** comprise elastomer dots that span the gap from substrate **200** to substrate **205** (minus the thickness of conductive traces **210** and **215**). By way of example, if substrate **200** is separated from substrate **205** by 10 μm, compressible media elements may be arranged and spaced as shown in FIGS. **3**A and **3**B. In one embodiment, compressible media elements may be applied to substrate **200** or **205** via a photolithographic or silk-screening process. In another embodiment, compressible media elements may be applied to both substrate **200** and **205**. In this later implementation, the dots or beads formed on a first substrate (e.g., substrate **200**) could be juxtaposed between dots or beads formed on the second substrate (e.g., substrate **205**) so that, together, the pattern illustrated in FIG. **3** would be constructed. It will be recognized by those of ordinary skill that other patterns are possible without departing from the concepts described herein.

While not required, in one embodiment volume **220** is closed in a manner that permits fluid to fill the region between substrate **200** (and conductive traces **210**) and substrate **205** (and conductive traces **215**). One benefit of this configuration is that the refractive index of the fluid may be matched with the refractive index of the compressible media elements. When this is done, Snell's law ensures that the compressible media elements will appear to vanish from a user's point of view and, as a consequence, not distract from the user's view of whatever is being presented on display element **110**. One illustrative optical fluid is SL-5267 from SantoLight. One of ordinary skill in the art will recognize that thin-film reflective coatings may be applied to each interface to reduce the loss of light and mitigate refractive distortions. Illustrative antireflective coatings may contain magnesium fluoride, aluminum oxides, etc. and are typically applied in thicknesses of approximately 50 to 200 nanometers.

Referring to FIG. **4**, the layout for conductive traces **210** and **215** are shown in accordance with one embodiment of the invention. In the illustrated embodiment, "top" traces **210** (i.e., those closest to user **120**) comprise rows of pixel plates **400**, drive frames **405** and inverted drive lines **410**—each of which is electrically isolated by regions having no conductive material **415**. "Bottom" traces **215** (i.e., those furthest from user **120**) comprise sense lines associated with force detection operations (**420**) and sense lines associated with location detection operations (**425**). As shown in the illustrated embodiment, each force detection trace **420** has an output pad (**430**, **435** and **440**) while a plurality of location detection traces **425** share a common output pad (**445** and **450**).

Referring to FIGS. **5**A and **5**B, a more detailed view of the architecture of FIG. **4** is provided. For one embodiment, the dimensions 'a' through 'h' identified in FIGS. **5**A and **5**B are listed in Table 1.

TABLE 1

Illustrative Dimensions

Label	Description	Size
a	Capacitive plate (400)	4 mm
b	Capacitive plate (400)	4 mm
c	Drive frame - inverted drive line separation	0.25 mm
d	Inverted drive line (410)	0.25 mm
e	Conductive trace separation	30 μm
f	Capacitive plate separation	0.25 mm
g	Sense trace width	300 μm
h	Sense trace (425) separation	0.67 mm

It will be recognized that the precise size of each element is a design decision that may be determined by the size of the display area (e.g., unit **100**) and the desired resolution. It will also be recognized that overlapping conductive traces **210** (e.g., trace **425**) and **220** (e.g., traces **430** and **435**) form capacitive elements that operate in a manner described in the aforementioned pending patent application.

It is noted that in the architecture illustrated in FIGS. **4** and **5**, traces **210** substantially cover one surface of clear substrate **200** while traces **215** only minimally cover one surface of clear substrate **205**. As a result, a user may see visual artifacts caused by the difference in the index of refraction between the surface of substrate **200** substantially coated with conductive traces and the surface of substrate **205** which is only minimally coated. To reduce these visual artifacts, it has been found beneficial to coat the surface of substrate **205** continuously with the transparent or translucent conductive trace